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Association between the Independent Variables with Knowledge Level of Adopter and Non-adopter Farmers about the Solar-powered Water Pumping System in Haryana

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A solar-powered pump operates on electricity generated by solar photovoltaic panels from collected sunlight rather than grid electricity or diesel. Consequently, solar energy serves as both a solution to the ongoing energy crisis and an environmentally friendly alternative. Demonstrating this shift, India's cumulative installed solar capacity reached 55 GW, with grid-connected utility-scale projects contributing 77 per cent, grid-connected rooftop solar making up 20 per cent, and mini or micro off-grid projects accounting for the remaining 3 per cent. Against this backdrop, the present study was undertaken to analyze the association between independent variables and the knowledge level of both adopter and non-adopter farmers regarding solar-powered water pumping systems in Haryana. Three districts, Yamunanagar, Jhajjar and Hisar of Haryana state were selected purposively and two villages were selected randomly from each of the three districts. A total of 40 farmers from each of the three districts were selected, and from each of 6 villages, 10 farmers who adopted SPWP and 10 who did not adopt SPWP were selected to measure knowledge, attitude and training needs. As a result, the researcher carried out personal meetings with 120 farmers at their farms or homes. Education (r=0.270), income (r=0.268), land holding (r=0.273), social participant (r=0.254), knowledge of govt. policies (r=0.251) and risk orientation (r=0.271) were positively correlated with the knowledge level of adopter SWPS, whereas SWPS non-adopters, age (r = -0.096), family size (r=-0.095), land holding (r=-0.216), and risk orientation (r=-0.097) were negatively correlated with knowledge level and were not significant.

Keywords: Solar, pump, energy, farmers, knowledge, adopter, correlation

A solar-powered pump operates on electricity generated by solar photovoltaic panels from collected sunlight rather than relying on grid electricity or diesel. Its operation is highly economical due to lower operation and maintenance costs, and it carries a significantly lower environmental impact than conventional internal combustion engine (ICE) pumps. This makes solar pumps exceptionally useful in areas where grid electricity is unavailable and alternative sources, such as wind, are insufficient. Over the last decade, global focus has increasingly shifted toward expanding renewable energy utilization, with solar energy emerging as a primary alternative; when integrated into the agricultural ecosystem, it has successfully opened up new possibilities for sustainable solar water pumping.

Renewable energy stands as the most abundant energy source globally, with solar energy emerging as both a vital solution to the current energy crisis and an environmentally friendly option. Among the methods used to capture this resource, photovoltaic (PV) generation represents a highly efficient approach for effectively harnessing renewable energy. Solar panels, comprising arrays of PV cells, are now widely deployed for illuminating street lights, powering water heaters and meeting household energy demands. The decreasing cost of solar panels continually encourages their adoption across various sectors. Among its applications, solar-powered irrigation systems have gained traction among farmers, presenting a sustainable solution amidst India's energy challenges.

India's solar power potential exceeds 750 GW, with the country's cumulative installed solar capacity reaching 55 GW as of December 2021, comprised of grid-connected utility-scale projects (77%), grid-connected rooftop solar (20%), and mini or micro off-grid projects (3%). Within this framework, the Haryana Government introduced a subsidy of up to 75% on solar pumps ranging from 3 HP to 10 HP for farmers under the PM-KUSUM program for 2023-24. Under this scheme, for pump capacities between 3 HP and 7.5 HP, farmers contribute only 25% of the cost, while the MNRE provides a 30% subsidy and the state government covers the remaining 45%.

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For 10 HP pumps, the farmer's share remains 25%, but the MNRE subsidy is capped at the 7.5 HP rate, leaving the state government to absorb the rest of the subsidy portion; this targeted initiative successfully drove a record installation of 87,757 solar pumps across Haryana between 2020 and 2023.

This study conducts a comparative analysis of adopters and non-adopters of solar-powered water pumping systems in Haryana and Rajasthan, two northern Indian states that share parallel challenges such as groundwater depletion, unreliable grid electricity supply, and a critical need for sustainable agricultural practices. Despite these geographic and environmental similarities, the two states diverge significantly in their socio-economic profiles, regional farming practices, and localized renewable energy policies. Consequently, this comparative approach offers valuable insights into the distinct contextual factors that drive or hinder the adoption of solar-powered irrigation systems across varying administrative and cultural landscapes.

Objectives of the Study

- To assess the knowledge of adopters and non-adopters of solar-powered water pumping systems.
- To know the attitude of adopter and non-adopter farmers towards the solar-powered water pumping system.
- To identify the constraints perceived by the adopter and non-adopter farmers' adoption of the solar-powered water pumping system.
- To ascertain the training needs of adopter and non-adopter farmers of the solar-powered water pumping system.

Method

This study was purposively conducted in the Yamunanagar, Jhajjar, and Hisar districts of Haryana due to their high concentration of farmers who have installed solar photovoltaic water pumps (SPWP). From each of these three districts, two villages were randomly selected, establishing a total of six villages for comprehensive data collection. Beneficiary farmers who had installed SPWP were available in the Department of New and Renewable Energy, Haryana. From this list, one district from each zone with the maximum number of farmers who had installed SPWP was selected purposely. Three districts, namely, Yamunanagar (Zone-I), Hisar (Zone-II) and Jhajjar (Zone-III) were selected purposely.

In the Hisar district, the following villages were selected, namely Ludas and Nangthala, from Jhajjar district, Madana Kala and Amadalpur and from Yamunanagar district, Naharpur and Tigri. A total of 40 farmers from each of the three districts were selected and from each of 6 villages, 10 farmers who adopted SPWP and 10 who did not adopt SPWP were selected to measure knowledge, attitude and training needs. As a result, the researcher carried out personal meetings with 120 farmers at their farms or homes.

Procedure

To collect data for the study, a well-structured interview schedule was prepared and administered through separate, personal interviews with respondents at their farms and homes to assess their socioeconomic status, knowledge, adoption levels, and constraints.

Statistical Analysis

The data collected from the respondents' schedules were suitably coded and analyzed using descriptive and inferential statistical tools-specifically frequency, percentage, mean, standard deviation, correlation, and regression-to draw meaningful inferences.

Results and Discussion

The given data in Table 1 appeared to represent the correlation coefficients (r-values) between various independent variables and two groups of participants: SWPS adopters and SWPS non-adopters. The correlation coefficients indicated the strength and direction of the relationship between each independent variable and the knowledge of SWPS.

Is can be concluded from table 1 that out of 15 independent variables, SWPS adopters age had negative correlation (r = -0.161), cast (r=-0.135), family size (r=-0.101), Mass media exposure (r=-0.051), farm machinery (r=-0.027) were negative correlations with knowledge level and non-significant but source of irrigation variable (r=-0.262) was negative correlation with significant at 0.05%.

While education (r=0.270), income (r=0.268), land holding (r=0.273), social participant (r=0.254), knowledge of govt. policies (r=0.251) and risk orientation (r=0.271) were positively correlated with the knowledge level of adopter SWPS, with a significant correlation at 0.05%, whereas cropping system (r= 0.340), extension contact (r= 0.353) and innovativeness (r=0.361) variables were strongly positive correction with significant correlation at 0.01%. These results conform with the results of (Savitharamma, 2011; Dalip, 2021; Shen et al., 2015; Kumar et al., 2018; & Ramrao, 2018).

Among SWPS non-adopters, age (r = -0.096), family size (r=-0.095), land holding (r=-0.216), risk orientation (r=-0.097) were negative correlations with knowledge level and non-significant, but education (-0.261) and source of irrigation (r=-0.262) were negative correlations with significant at 0.05% and significant at 0.01% respectively.

The independent variables cast (r=0.164), land holding (r=0.186), mass media exposure (r=0.129), and knowledge of the government. policies (r=0.045) and farm machinery (r=0.040) were non-significant with positive correlation with the knowledge level of non-adopter SWPS, whereas income (r=0.283) and social participant (r=0.255) were positive correlation with significant at 0.05%. The aforementioned result aligns with the research conducted by Naseem et al. (2016), Shen et al. (2015), and Sowjanya (2014).

Multiple Regression Analysis between Independent Variables and the Knowledge Level of Respondents towards SWPS in Haryana

In Table 2, multiple regression analysis revealed from a first glance that at the 0.01 and 0.05 level of probability, it was discovered that education, income, landholding, mass media exposure, extension contact, knowledge of Govt. schemes, and risk orientation all had positive and significant regression coefficients. With the knowledge of SWPS adopted farmers, it was discovered that age, caste, family size, cropping system, innovativeness, and farm machinery had positive but non-significant regression coefficients. Further evidence may be seen in Table 2, which demonstrates that all background variables together accounted for 61.70 per cent of the difference in adopted farmers' knowledge. At the 0.01 and 0.05 levels of probability, it was determined that the estimated "F" value was significant. That was to say, one unit change in the degree of

Table 1

Relationship between Selected Independent Variables and Knowledge Level of Respondents towards SWPS in Haryana

S. No.	Independent Variables	SWPS Adopters (n=60) Correlation coefficient (r)	SWPS Non-adopters (n=60) Correlation coefficient (r)
1.	Age	-0.161 NS	-0.096 NS
2.	Caste	-0.135 NS	0.164 NS
3.	Education	0.270*	-0.261*
4.	Family size	-0.101 NS	-0.095 NS
5.	Income	0.268*	0.283*
6.	Landholding	0.273*	-0.216 NS
7.	Cropping system	0.340**	0.186 NS
8.	Social participation	0.254*	0.255*
9.	Mass media exposure	-0.051 NS	0.129 NS
10.	Extension contact	0.353**	0.345**
11.	Innovativeness	0.361**	0.269*
12.	Knowledge of Govt. Policies	0.251*	0.045 NS
13.	Farm machinery	-0.027 NS	0.040 NS
14.	Source of irrigation	-0.262*	-0.339**
15.	Risk orientation	0.271*	-0.097 NS

education, income, land holding, mass media exposure, extension contact, knowledge of Govt. schemes and risk orientation resulted in a comparable change in the farmers who adopted the SWPS in terms of their knowledge. However, in case of non-adopters, age, caste, family size, landholding, cropping system, mass media exposure, innovativeness, knowledge of Govt. policies, farm machinery and source of irrigation were found to have positive but non-significant relationships, whereas education, income, social participation, extension contact and risk orientation were found to have positive and significant relationships. The regression coefficient also revealed that the background variables as a whole explained 50.20 per cent of the variation in SWPS's non-adopted farmers. A 0.05 level of probability was used to determine whether the estimated "F" value was significant. The results were supported by Kumar et al. (2018).

Table 2

Multiple Regression Analysis between Independent Variables and Knowledge Level of Respondents towards SWPS in Haryana (n=120)

S. No.	Independent variables	SWPS Adopters (n=60) Regression coefficient			SWPS Non-adopters (n=60) Regression coefficient		
		b-value	t-value	p-value	b-value	t-value	p-value
1.	Age	-0.045	-0.728	-0.470NS	-0.027	-0.319	0.750NS
2.	Caste	-0.555	-1.121	-0.268NS	1.269	1.405	0.166NS
3.	Education	0.014	0.0259	0.019**	0.009	0.012	0.044*
4.	Family size	0.337	0.644	0.522NS	-1.653	-1.433	-0.158NS
5.	Income	0.324	0.504	0.042*	2.280	1.477	0.034*
6.	Landholding	1.351	1.514	0.037*	-4.528	-1.678	-0.100NS
7.	Cropping system	1.271	1.979	0.322NS	0.573	0.460	0.647NS
8.	Social participation	0.032	0.041	0.017**	0.443	0.232	0.038*
9.	Mass media exposure	0.031	0.098	0.022*	0.034	0.063	0.949NS
10.	Extension contact	0.506	2.408	0.020**	0.255	0.534	0.046*
11.	Innovativeness	0.067	0.354	0.720NS	0.671	2.653	0.430NS
12.	Knowledge of Govt. policies	0.071	0.152	0.041*	-0.221	-0.251	-0.802NS
13.	Farm machinery	0.182	0.671	0.505NS	0.364	0.541	0.591NS
14.	Source of irrigation	-0.594	-1.185	-0.242NS	1.237	1.254	0.216NS
15.	Risk orientation	0.599	1.346	0.038*	0.066	0.200	0.039*
	R^2	0.617			0.502		

Note. * Significant at 0.05%, ** Significant at 0.01% and NS = Non Significant

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